General

Guideline Title

Official American Thoracic Society technical standards: spirometry in the occupational setting.

Bibliographic Source(s)

Redlich CA, Tarlo SM, Hankinson JL, Townsend MC, Eschenbacher WL, Von Essen SG, Sigsgaard T, Weissman DN, American Thoracic Society Committee on Spirometry in the Occupational Setting. Official American Thoracic Society technical standards: spirometry in the occupational setting. Am J Respir Crit Care Med. 2014 Apr 15;189(8):984-94. [100 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Technician Training

Technicians should undergo initial practical training and refresher courses to maintain their skills. Technicians should also receive on-going feedback about the quality of tests that they perform, and how to correct problems in test performance.

Posture During Spirometry

Standing or sitting test posture can be used, but the same posture should be used when possible on repeat testing, and this should be documented. The rationale is that posture-related changes in forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC), although small, may significantly impact spirometry interpretation.

Reference Values

Racial or ethnic differences in lung function exist. It is preferable to use specific reference equations (such as the National Health and Nutrition Examination Survey [NHANES] III) that have been developed from studies of certain populations when they are available (Pellegrino et al., 2005). When such reference equations are not available, however, the use of correction factors is an appropriate interim solution. As an example, a correction factor of 0.88 may be applied to white subject reference values for FEV_1 and FVC when evaluating Asian populations within North America.

Evaluation of Spirometry Over Time

Spirometry measurements should be evaluated relative to workers' baseline or prior tests, in addition to comparing to population normal ranges. This is particularly important when baseline measurements exceed predicted values. FEV_1 decline over time should be evaluated using one or more of the approaches described, and interpreted in the context of worker exposures, symptoms, and other clinical information.

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Workplace inhalation exposures that can affect lung function and cause or exacerbate lung diseases, such as asthma, chronic obstructive pulmonary disease (COPD), or fibrosis

Guideline Category

Evaluation

Screening

Clinical Specialty

Allergy and Immunology

Family Practice

Internal Medicine

Pulmonary Medicine

Intended Users

Allied Health Personnel

Physicians

Public Health Departments

Respiratory Care Practitioners

Utilization Management

Guideline Objective(s)

- To address spirometry performed as part of a workplace respiratory health program
- To address aspects of the performance and interpretation of spirometry that are particularly important in the workplace, where inhalation exposures can affect lung function and cause or exacerbate lung diseases, such as asthma, chronic obstructive pulmonary disease (COPD), or fibrosis

Target Population

Adult workers (age 19-64 years) in occupational settings where spirometry is performed

Interventions and Practices Considered

1. Spirometry training and refresher courses for technicians
2. Sitting or standing position (same posture should be used for repeated testing and documented)
3. Reference equations or correction factors (as needed for racial or ethnic differences)
4. Evaluation of spirometry measurements relative to workers' baseline

Major Outcomes Considered

- Equipment considerations
- Testing technique
- Technician training and feedback

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Methods

A systematic review of the literature was conducted. A professional medical librarian searched Medline for articles from 1950–2012 and EMBASE for articles from 1980–2012. Details of search terms used, criteria for inclusion/exclusion, and methods for review of the papers are given in the online supplement (see the "Availability of Companion Documents" field). Because there were limited numbers of papers identified in the systematic reviews that were based on work populations, the committee also considered indirect evidence from studies conducted in alternative settings or with nonoccupational populations. Additional relevant papers identified by committee members were included.

Questions

Four questions were identified for systematic review:

1. Which training requirements are needed for performance of spirometry in the occupational setting?
2. Is there a difference in results or safety between occupational spirometry test performance sitting vs standing?
3. Is there a correction factor that can be provided for workers in North America and Europe of Asian ethnicity?
4. What is the longitudinal change in spirometry that should be taken as an action level in occupational spirometry?

For all questions, the search was limited to adults (19-64 years), no limits were placed in the abstract search by language or study type except for the question 4, and the databases searched were Medline and EMBASE.

For each question a systematic review was performed with assistance from a medical librarian using Medline and EMBASE with the search strategies as shown below, initially to 2009 and then extended to the end of April 2012, using the same search strategies. Additional relevant papers were added by the panel from review of references in the papers from the search or from personal knowledge of the literature. Abstracts were all screened by 2 panel members to identify those meeting inclusion criteria and full papers then obtained for data extraction by 2 panel members using the forms developed for each question (included below).

Inclusion Criteria, Exclusion Criteria, and Search Results

Question #1: Which training requirements are needed for performance of spirometry in the occupational setting?

Inclusion criteria were: spirometry testing; the study details included the type of person doing the testing (e.g., pulmonary function technologist); some comparison or analysis of the impact of training of the technician or some educational component; the outcome of quality of spirometry or other outcome. In addition, selected review articles were included to identify additional references.

Exclusion criteria were studies that did not include spirometry; included only patient training; or included only equipment quality control.

Search results to 2009: 1480 total abstracts were identified after removal of duplicates (681 Medline, 799 EMBASE) of which 20 papers met the full criteria. From the extended search to the end of April 2012 (136 Medline, 944 EMBASE abstracts) an additional two papers were identified for a total of 22 papers, summarized in Table E1 in the online supplement.

Question #2: Is there a difference in results or safety between occupational spirometry test performance sitting versus standing?

The search led to a total of 2865 abstracts: from Medline 2060 abstracts, with an additional 805 in EMBASE after excluding duplicates. From the 2865 abstracts initially identified, only 10 full papers were identified which met the following inclusion criteria: sitting and standing tests were performed in adults, on the same subjects, the outcome included spirometry (forced expiratory volume in 1 second [FEV_1] and forced vital capacity [FVC]), and the abstract of the paper was in English. Three of these papers were excluded, as they were not in English, leaving 7 papers, summarized in Table E2 in the online supplement. No additional papers suitable for inclusion were identified from the extended search to the end of April 2012 (292 Medline and 430 EMBASE abstracts).

Question #3: Is there a correction value that can be provided for workers in North America and Europe of Asian ethnicity?

Inclusion criteria were: Race – Asian, Indian; abstract in English; population group – smokers and non-smokers; occupational cohorts were included if there was also a control group. Excluded were studies with only children; identified disease groups – e.g., chronic obstructive pulmonary disease (COPD).

From the initial searches to 2009, a total of 515 abstracts were identified that met these criteria: 321 from the Medline search plus studies known to the panel members and an additional 194 from EMBASE after excluding duplicates. Studies of adult Asians and Indians living in the U.S., Canada, or Europe, including non-smokers and/or smokers were included. Studies of Asians in other countries and of disease groups such as COPD were then omitted, leaving 6 articles used for the evidence-based review. This increased by one additional article by the extended search to the end of April 2012 (459 Medline, 225 EMBASE abstracts) for a total of 7 articles, as summarized in Table E3 in the online supplement.

Question #4: What is the longitudinal change in spirometry that should be taken as an action level in occupational spirometry?

Inclusion criteria were: at least 3 spirometry time points over at least 5 years; general population studies, or occupational cohorts that included either normal controls or low exposure group(s); smokers and non-smokers were included. Studies had to include an assessment of variability in FEV_1 decline. After the review was initiated, it became apparent that studies evaluating occupational cohorts where early measures of decline could be evaluated for ability to predict longer-term decline in individuals were useful, so these were also considered.

Exclusion criteria were: occupational cohorts without a control group (except studies where early measures of decline were evaluated for ability to predict longer-term decline in individuals, as noted for inclusion criteria); disease cohorts, e.g., COPD; multiple studies of the same population – the study with the best methods were selected if there were several studies.

There were 814 total abstracts from the searches to 2009, excluding duplicates: Medline 585, EMBASE 229. Of these, 79 were selected for full paper review. When combined with results from the extended search to the end of April 2012 (95 Medline, 333 EMBASE abstracts), a total of 6 papers from 97 with full review completely fulfilled the criteria (summarized in Table E4 in the online supplement).

Number of Source Documents

- Question #1: 22 papers
- Question #2: 7 papers
- Question #3: 7 articles
- Question #4: 6 papers

Methods Used to Assess the Quality and Strength of the Evidence

Expert Consensus

Rating Scheme for the Strength of the Evidence

Not applicable

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Evidence tables were constructed. See Tables E1-E5 in the online supplement (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

The project co-chairs were selected by the leadership of the Environmental and Occupational Health Assembly on the basis of their experience in group leadership and occupational medicine. Committee members were selected based upon their expertise in pulmonary medicine, occupational health, and/or spirometry.

Issues identified for detailed evidence based review of the literature were: (1) optimal training for technicians performing spirometry; (2) spirometry test posture; (3) reference values for Asian workers in North America and Europe; and (4) how to evaluate decline in lung function over time.

The full committee discussed the results of the systematic review in a series of meetings. Committee members were then divided into groups and assigned to write a portion of the document. The co-chairs collated and edited the contributions from each group into a single document, which was then reviewed by the full committee. After several cycles of review, comments, and revisions, the document was approved by all members of the committee for submission.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

This official clinical practice guideline of the American Thoracic Society (ATS) was approved by the ATS Board of Directors, December 2013.

Evidence Supporting the Recommendations

References Supporting the Recommendations

Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, Coates A, van der Grinten CP, Gustafsson P, Hankinson J, Jensen R, Johnson DC, MacIntyre N, McKay R, Miller MR, Navajas D, Pedersen OF, Wanger J. Interpretative strategies for lung function tests. Eu Respir J. 2005 Nov;26(5):948-68. PubMed

Type of Evidence Supporting the Recommendations

The type of evidence supporting the recommendations is not specifically stated.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Spirometry performed in the work setting should be part of a comprehensive workplace respiratory health program. Effective technician training and feedback can improve the quality of spirometry testing.

Potential Harms

- Even with good programs, spirometer inaccuracy and imprecision and survey biases (unexplained technical changes) may limit the size of the detectable change or contribute extraneous variability to longitudinal measurements.
- False-positive or false-negative results

Qualifying Statements

Qualifying Statements

Spirometry that is performed as part of a workplace spirometry program differs from clinical diagnostic spirometry in several key respects, including its purpose, patient-healthcare provider-employer relationships, and its role in individual and workplace decision making.

Implementation of the Guideline

Description of Implementation Strategy

Action Plan for Spirometry in the Work Setting

The key components of a workplace spirometry program should be supervised by the clinician responsible for performing spirometry testing (see Table 1 in the original guideline document). Groups eligible for spirometry monitoring should be defined based upon the potential respiratory hazards. The specific reason(s) spirometry is being performed should be clear, including the exposures of concern, which may dictate the frequency and/or timing of testing. Spirometry can be part of the medical evaluation for respirator use, in which case the employer should have a complete written respiratory protection program. The "action levels" that will be considered abnormal and trigger further evaluation need to be established, as well as a plan for when action levels are exceeded. Responsibilities for evaluation of both the individual and group spirometry and other health and workplace data should be clarified. Lines of communication should be established between the provider, worker, and employer that enable communication of relevant information, and also maintain confidentiality of medical information.

The results of spirometry performed in the work setting require careful interpretation (see Table 4 in the original guideline document). Clinicians involved should be familiar with the performance and interpretation of spirometry, and should have knowledge of the work exposures of concern. To protect worker confidentiality, providers must not disclose individual workers' personal health information to employers without employee consent.

The technical quality of spirometry testing and accuracy of demographic information should always be reviewed. Consider repeat testing if tests are invalid; lack of repeatability, in particular, may indicate disease. The measured values from spirometry should be compared with predicted reference values, and levels below lower limit of normal (LLN) identified. Current spirometry results should be compared with available prior testing, even if above the LLN. Excessive decline in forced expiratory volume in 1 second ($FEV_{1)}$ should be determined using one of the approaches discussed here (see Table 3 in the original guideline document). Workers with values below the LLN and/or an excessive decline in FEV_1 should be further evaluated for potential causes and preventable risk factors. Factors such as work exposures, respiratory symptoms, and medical information (e.g., diagnoses, medications) should always also be considered, as spirometry values or rates of decline can remain "normal" when other factors may indicate that further evaluation is needed.

The specific steps to be taken will depend on several considerations, including the exposures of concern, the magnitude of the lung function abnormality and/or decline over time, and the clinical context (see Table 5 in the original guideline document). A careful occupational history, including workplace exposures and work-related symptoms, should be obtained, and baseline/follow-up questionnaires should be reviewed. Further workup may include more complete pulmonary function testing (e.g., lung volumes, diffusing capacity) and chest imaging (radiographs, computerized tomography scan). Detailed algorithms and guidelines exist for specific work-related pulmonary diseases, and are beyond the scope of this article. Appropriate interventions could include improved administrative or engineering controls to reduce exposures, termination of implicated occupational exposures, smoking cessation, and/or treatment of medical conditions, such as asthma.

In addition to management of the individual worker, the analysis of aggregate worker data (from the same workplace, company, job, or industry), both cross-sectional and longitudinal, can offer significant benefit. Spirometry, questionnaire, other health data, and exposure and job information can be linked for further evaluation while also being de-identified to protect individual worker privacy. Associations can be identified between work factors (exposures, job tasks, work locations) and lung function, which can easily be missed when reviewing workers individually, helping to target preventive efforts, such as reduction of potentially hazardous exposures. Such analysis can also help employers assess the effectiveness of current workplace preventive measures and better focus further preventive efforts. The distribution of individuals with spirometry abnormalities by job category, location, and/or task should be evaluated. Although additional expertise and support from the employer is needed for more complex aggregate analysis of spirometry and other available data, such analysis is strongly encouraged, as it may permit identification and control of exposure-related health problems. The computerization of medical and workplace data should greatly facilitate such aggregate data analysis.

Implementation Tools

Staff Training/Competency Material

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Staying Healthy

IOM Domain

Effectiveness

Safety

Identifying Information and Availability

Bibliographic Source(s)

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Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2014 Apr 15

Guideline Developer(s)

American Thoracic Society - Medical Specialty Society

Source(s) of Funding

American Thoracic Society (ATS)

Guideline Committee

American Thoracic Society Committee on Spirometry in the Occupational Setting

Composition of Group That Authored the Guideline

Committee Members: Carrie A. Redlich (*Co-chair*), MD, MPH; Susan M. Tarlo (*Co-chair*), MB BS; John L. Hankinson, PhD; Mary C. Townsend, DrPH; William L. Eschenbacher, MD; Susanna G. Von Essen, MD, MPH; Torben Sigsgaard, MD, PhD; David N. Weissman

Financial Disclosures/Conflicts of Interest

Potential conflicts of interest among the chairs and committee members were disclosed, vetted, and managed according to the policies and procedures of the American Thoracic Society (ATS).

Author Disclosures

J.L.H. is the owner of Hankinson Consulting, Inc., which has provided training and consultation on spirometry to government agencies and commercial entities. M.C.T. is the owner of M.C. Townsend Associates, LLC, which has provided training and consultation on spirometry to government agencies and manufacturing companies. T.S. was a consultant to Airsonett AB ($1,000–9,999) and served on an advisory committee of the Rockwool Group ($5,000–24,999). C.A.R., S.M.T., W.L.E., S.G.V.E., and D.N.W. reported no relevant commercial interests.

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the American Thoracic Society (ATS) Web site.

Availability of Companion Documents

The following are available:

- Official ATS technical standards: spirometry in the occupational setting. Online supplement. 2014 Apr. 41 p. Available from the American Thoracic Society (ATS) Web site.
- Workplace spirometry: early detection benefits individuals, worker groups and employers. Clinical case presentation. Available from the ATS Web site.

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on February 18, 2016. The information was verified by the guideline developer on March 15, 2016.

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